

Behind the River Plate Facade: A Digital Approach

The façade of the parking structure at Club Atlético River Plate represents a striking example of how computational design, digital fabrication, and physical simulation can converge to address complex architectural challenges. This parametric design not only evokes the iconic flag of the club but also demonstrates a sophisticated use of Rhino and Grasshopper, as well as various plugins, to overcome design and manufacturing hurdles.

We explore the creative and productive processes behind the façade's development, the role of technology, and the solutions devised to tackle the challenges that arose during its design and construction.

[River Plate Facade](#)

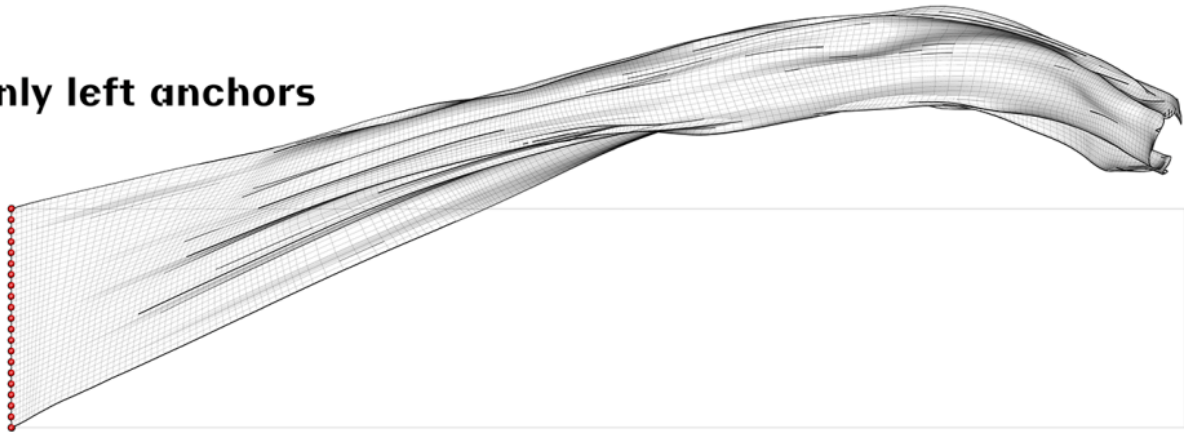
REPRESENTING THE FLAG: PHYSICAL SIMULATION IN KANGAROO2

The primary challenge for the façade design was to recreate a visual representation of the River Plate flag, with its distinctive colors and shape. A highly realistic simulation was required to emulate the flag's dynamic motion as it waves in the wind. This task could not be achieved without the use of [Kangaroo2](#), a plugin for [Grasshopper](#) that enables physical simulations.

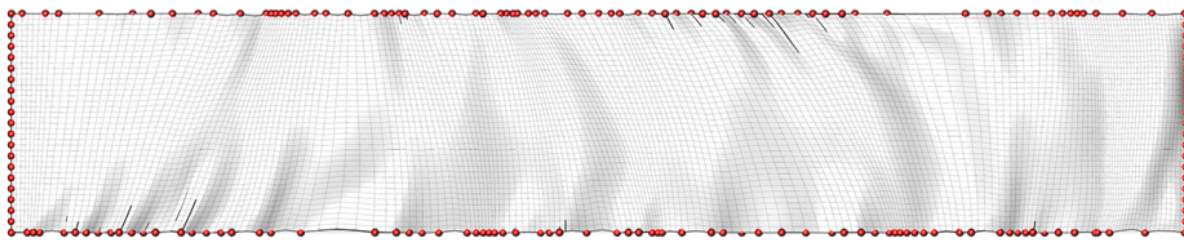
Using Kangaroo2, the design team created an animation that mimicked the fabric's behavior under the influence of wind. To achieve realistic folds and wrinkles, the mesh (a dense network of polygons) was subdivided to allow smoother and more defined distortions. However, an issue arose when the flag was fixed along a single edge, resulting in excessive wrinkling from wind movement. To maintain control over the deformations while keeping the look of the waving flag, additional fixations were added to the top and bottom edges. This solution balanced the visual realism with the practical constraints of construction.

Flag simulation

Only left anchors



All around anchors

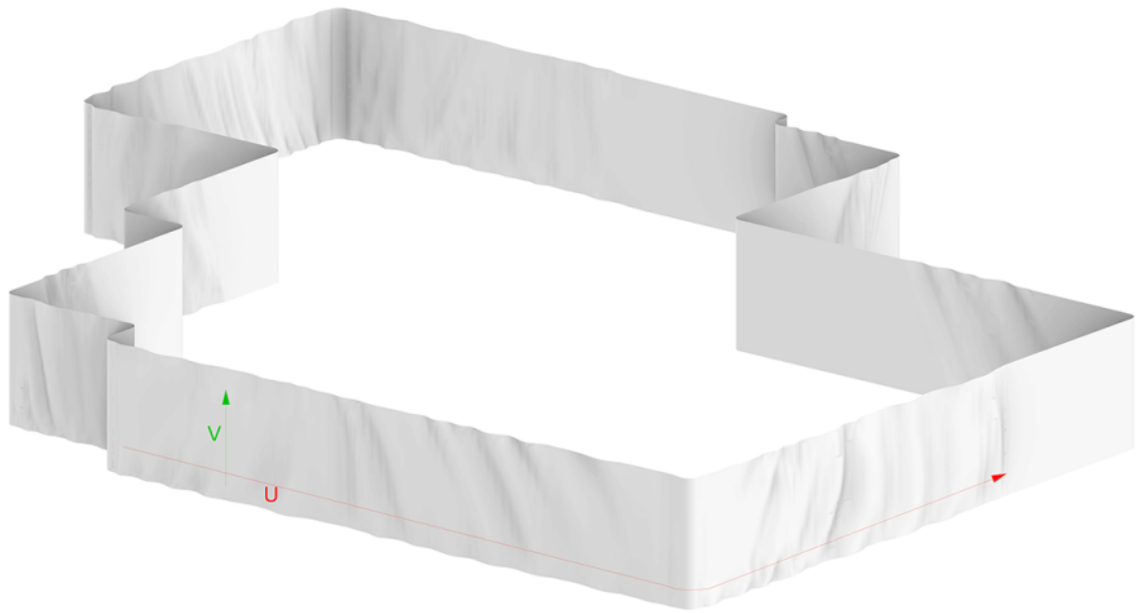


GEOMETRIC DISCRETIZATION: DIVIDING THE SURFACE INTO FABRICABLE PANELS

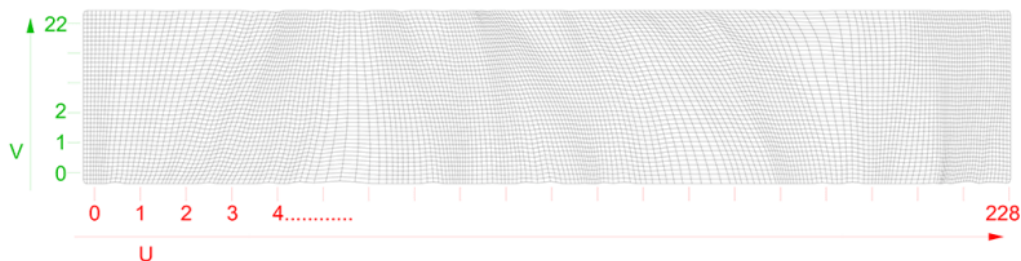
The result of the simulation was a mesh, which provided the foundation for further design steps. To ensure the façade could be constructed with panels of manageable size and shape, the mesh was transformed into [NURBS](#) geometry. This was done by defining a flat surface that covered the entire façade and establishing coordinates for the horizontal (u) and vertical (v) directions.

Panels were mapped along the u and v directions, with rows and columns numbered from 0 to 228 and 0 to 22, respectively. This structured approach not only ensured the panels could be assigned identification numbers easily, but also helped maintain the correct orientation of each surface's normal vector. This precise organization facilitated both the manufacturing and the assembly of the panels's capabilities without overwhelming the space with excessive physical elements.

Surface Subdivision



Unrolled surface subdivision & numeration



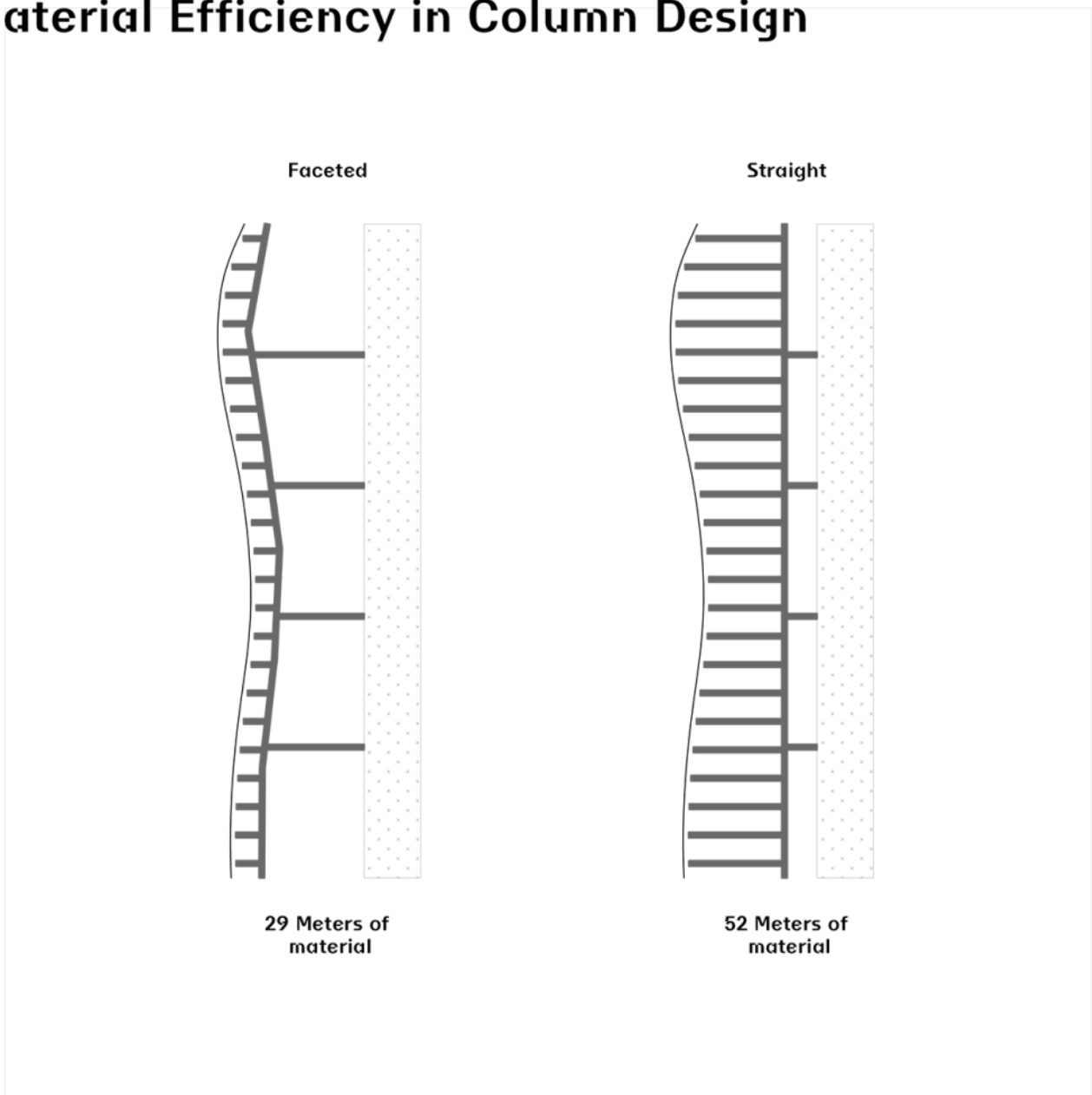
MAIN STRUCTURE: CONSTRUCTIVE OPTIMIZATION & MATERIAL EFFICIENCY

As the team began to model the main structure, they faced additional challenges related to material efficiency and production processes. The aim was to create a design that allowed for standardized, repeatable components to streamline production. However, the idea of more irregular, unique components emerged, which would reduce material use.

The decision to use 228 different columns made from laser-cut tubes

allowed for a significant reduction in material consumption. This move resulted in a lighter structure while maintaining efficient construction methods.

Material Efficiency in Column Design

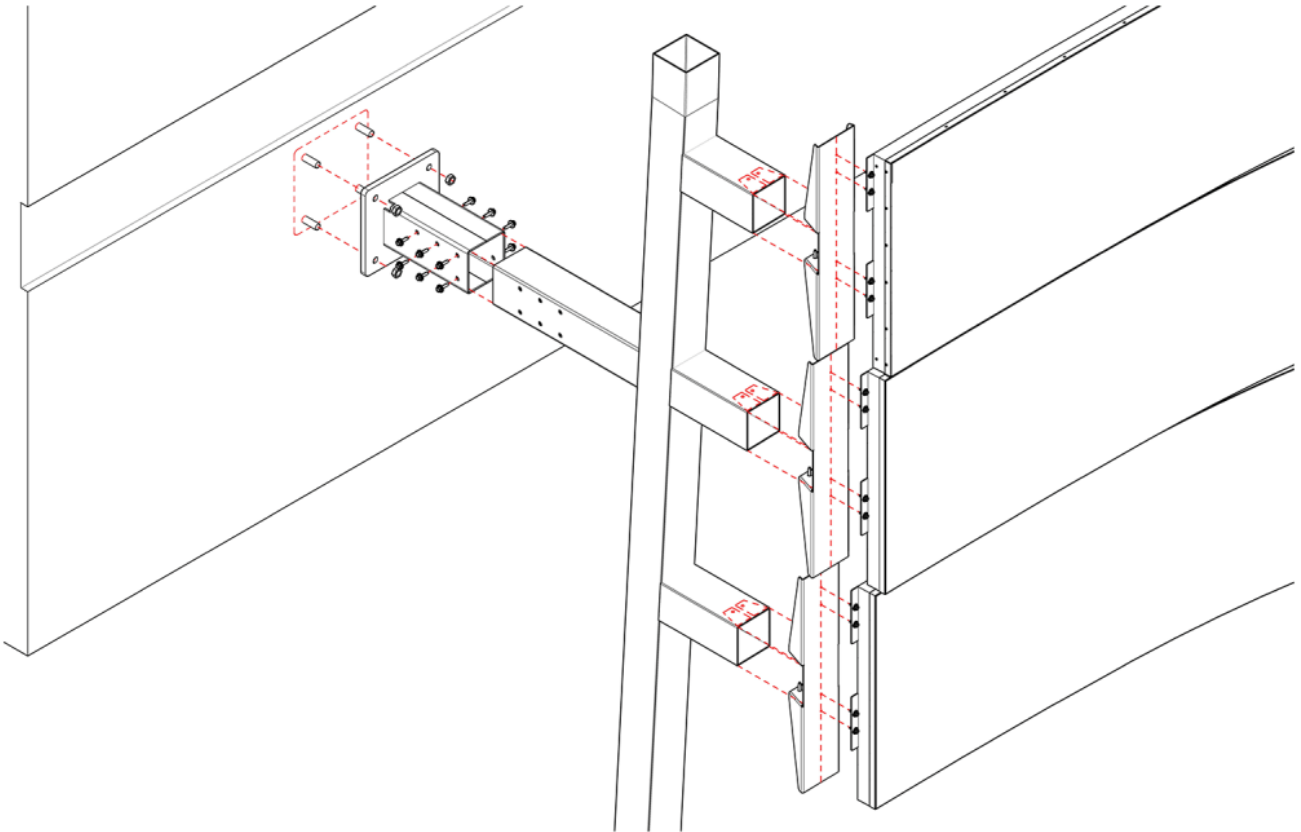


KEY PROCESSES: CODING, JOINTS, & ASSEMBLIES

CNC technology played a crucial role in the production of the custom panels and structural elements. Through parametric modeling in [Grasshopper](#), the design team could maintain a well-organized data structure tied to the façade's grid. This organization enabled a coding system that helped identify main components and their sub-

elements, ensuring proper assembly.

Moreover, each structural piece was given a unique geometry, allowing for an optimized fabrication process. Cut, engraving, and perforation marks were incorporated into the models to ensure proper evacuation of gases and liquids during the hot galvanization process, which streamlined construction.

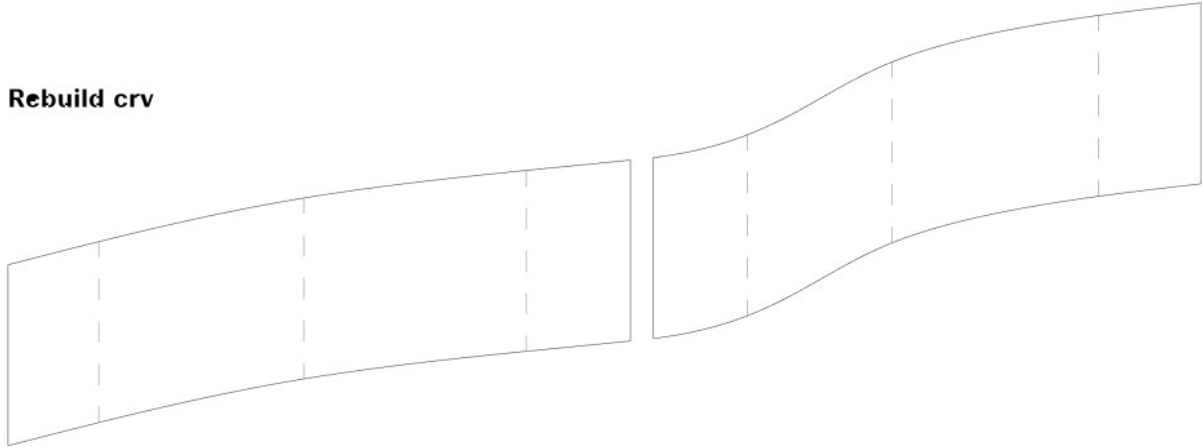


DATA OPTIMIZATION: STREAMLINING THE MANUFACTURING WORKFLOW

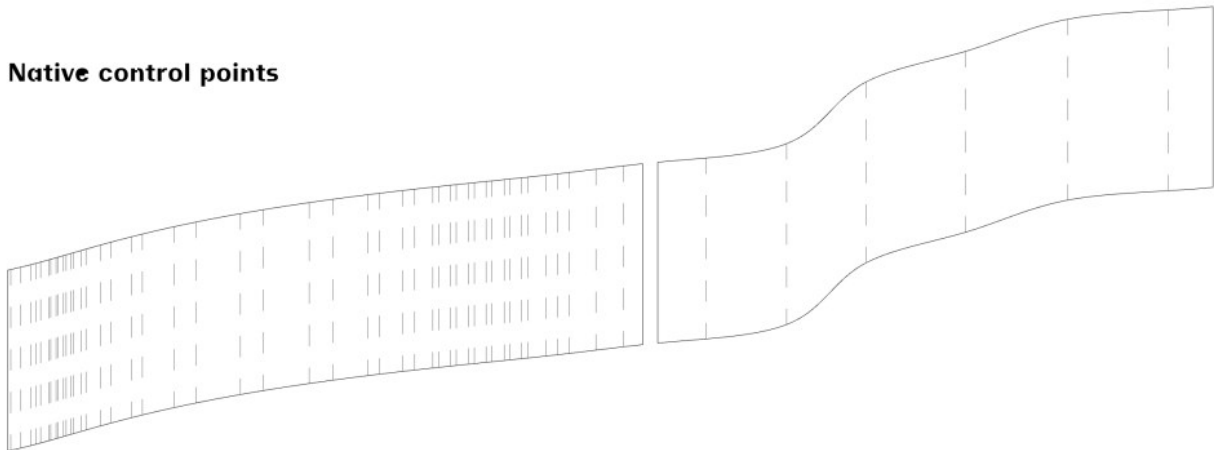
The process of optimizing the panel designs involved simplifying the curves that formed the panels' edges. While the initial mesh resulted in complex polylines with many control points, these were reduced to simpler curves with fewer points. This simplification was crucial for ensuring smooth and continuous edges, which were then used to define the structural frame of each panel.

Optimizing data

Rebuild crv



Native control points



KEY PROCESSES: HANDLING COMPLEX DATA

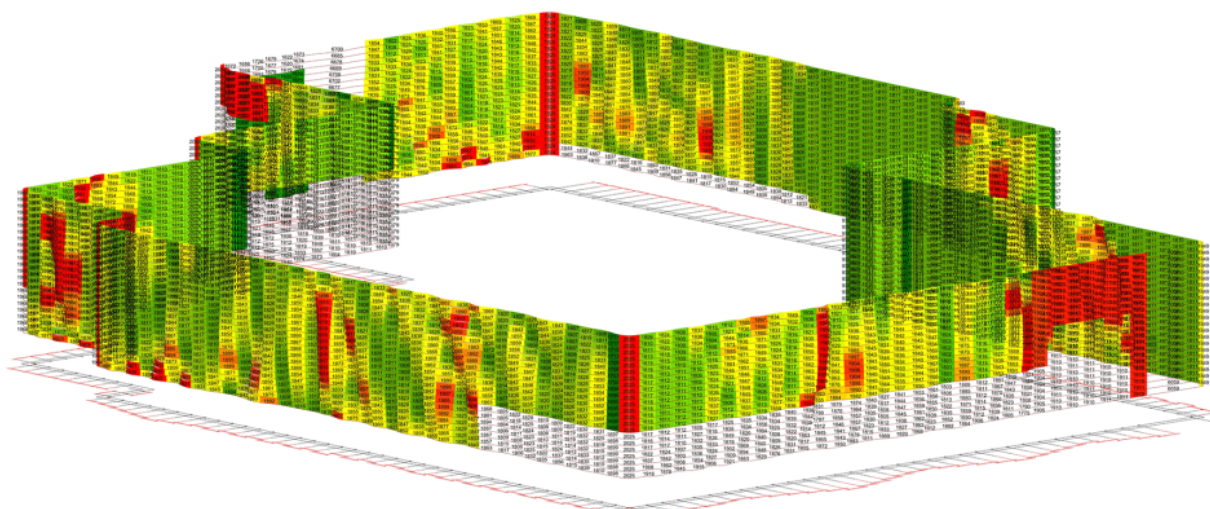
Given the magnitude and complexity of the River Plate façade project, it became clear that managing the entire design in a single 3D model or file was impractical. The large number of components and the need for parallel workflows required the team to break the process into key stages: constructing the main structure, generating the panels, creating the frames for the panels, and producing all the standard elements.

To facilitate this, Grasshopper's "data output" and "data input" tools were employed to maintain an organized workflow and ensure the exchange of essential manufacturing data, such as the normal vectors of the surfaces or the axis of the support structures for the panels. Additionally, the [Elefront](#) plugin was used to incorporate attributes into the geometry, allowing for a smooth data flow when exporting 3D and 2D files for CNC machines.

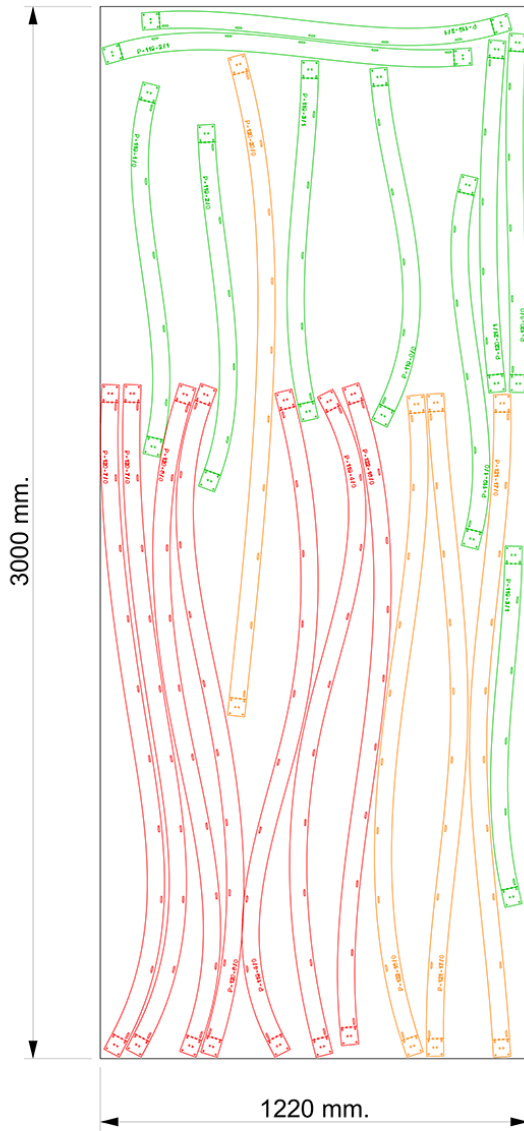
MATERIAL OPTIMIZATION: REDUCING WASTE

The parametric design process proved invaluable in enabling an iterative development stage where feedback could be incorporated to adjust the design. For instance, the aluminum ribs that defined the shape of the panels initially caused inefficient material use due to their excessive curvature, which hindered optimal nesting during manufacturing.

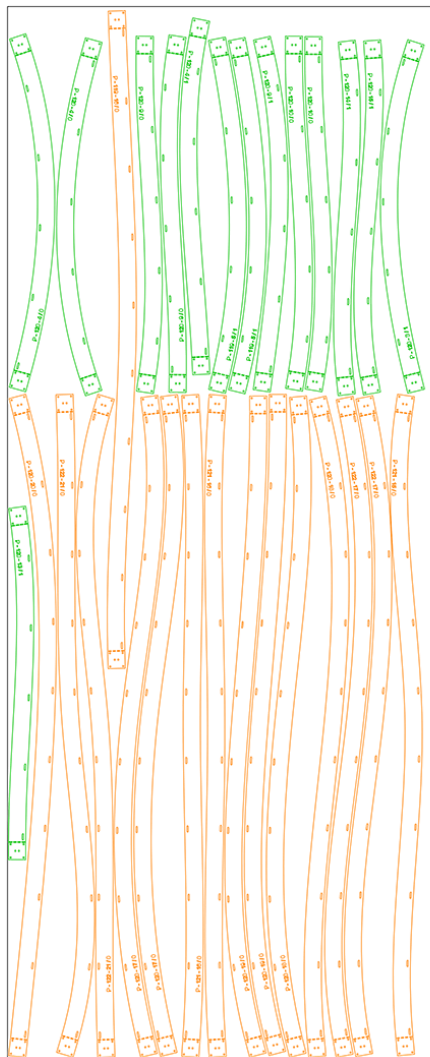
To address this, the ribs were split in half, allowing smaller parts to be made with less curvature. However, this caused unnecessary cuts for some panels, where no division was required. A new solution was introduced in the algorithm to analyze the curvature of each rib, determining whether a cut was needed based on the rib's specific curvature. This change significantly improved material use and eliminated unnecessary cuts.



Frame Nesting sample



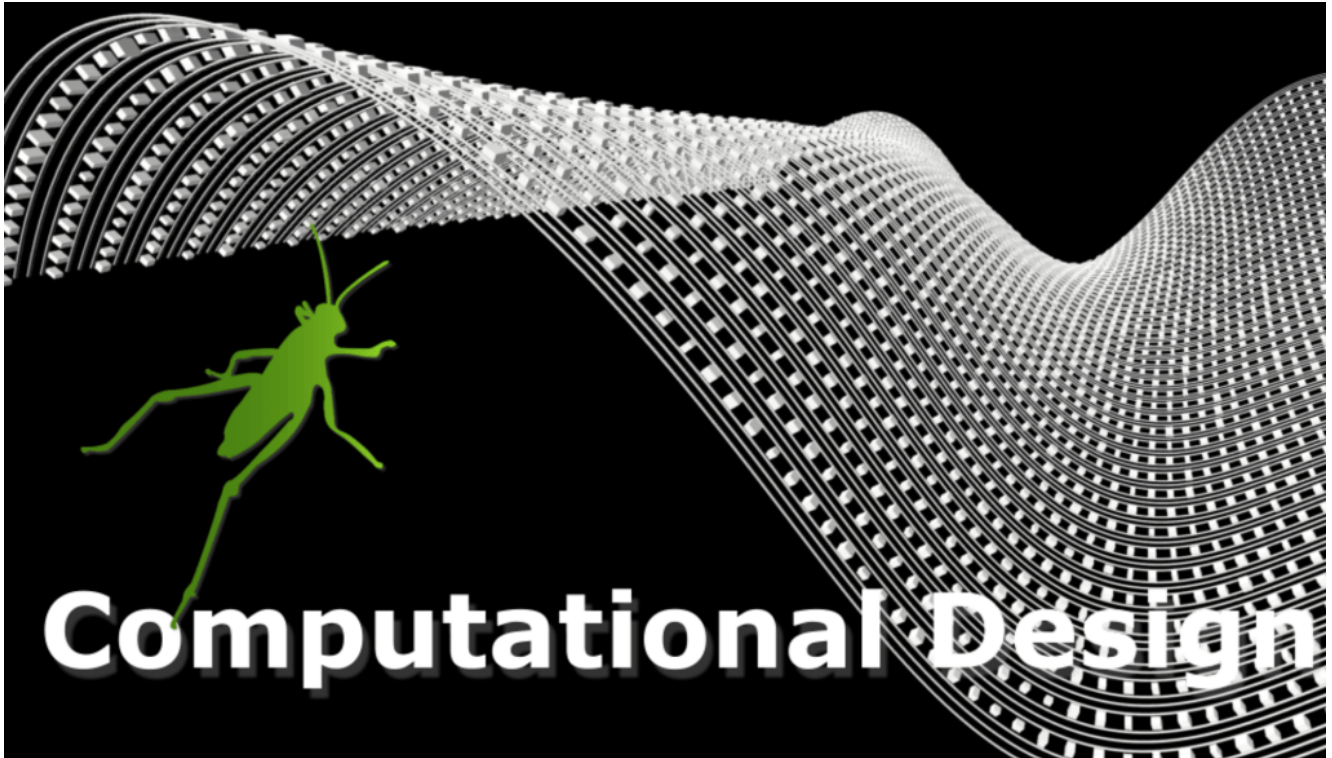
Nesting B_9



Nesting B_10

FABRICATION INFORMATION GENERATION: OPENNEST, ELEFRONT, & LUNCHBOX

Organizing the files for fabrication can often be tedious, but plugins like [OpenNest](#) were used to efficiently manage the nesting of parts on galvanized steel sheets. [Elefront](#) helped “bake” the data into files ready for processing, while [Lunchbox](#) was used to export fabrication data to Excel. This allowed for efficient tracking of components.



[See Also](#)

[COMPUTATIONAL DESIGN WITH GRASSHOPPER](#)

PANEL DIMENSIONS & MATERIAL CONSIDERATIONS

To optimize the fabrication of the 4,800 panels, the team carefully determined panel dimensions based on the material used, which was pre-painted galvanized steel coils. The chosen panel length averaged 1,800mm, accommodating the maximum cutting machine length and making transportation manageable. The width of the panels was based on the perforation grid, with each panel being no more than 600mm wide to ensure efficient manufacturing and handling.

KEY TAKEAWAYS

The River Plate façade project is an exemplary case of how computational design, physical simulation, and digital fabrication can

be combined to solve architectural challenges in innovative ways. Through the use of Rhino, Grasshopper, Kangaroo2, and other plugins, the design team successfully tackled issues related to geometry, material efficiency, and manufacturing constraints. This project demonstrates the transformative power of parametric design and digital tools in shaping the future of architecture.

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